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Interactive comment on "Nitrous oxide (N_2O) and methane (CH_4) in rivers and estuaries of northwestern Borneo" *by* Hermann W. Bange et al.

Anonymous Referee #2

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The available data set for greenhouse gas concentrations in tropical rivers/estuaries and the resulting emissions to air is small, so this paper makes a potentially valuable contribution in this area. The dataset was interesting and while some trends in the data were reflected in other studies cited, yet other studies found contrasting results that I felt were not duly considered or were ignored. I was therefore looking for some further discussion and my overall impression was that the treatment was a little simplistic in several areas. I therefore consider that some significant modifications to the text are required. These, and some additional minor comments, are listed below. L150: What certified gas standard values were used? L160-164: the mean relative errors of the gas analyses were acknowledged as being rather high and this was ascribed to long storage times. What were the storage times and were these the same for all samples? If not, is there any statistically significant difference between the errors for samples stored for "long" vs "short" times"? Also, was the greater sensitivity of CH_4 to storage shown by Wilson et al (2018) also the case here? This was not clear. L168-169: Was the pre-washing protocol described here and the method for collecting ancillary samples also used for gases? The description of dissolved gas sample collection was lacking in detail. L173: What was the precision of the DOC analyses? Supplementary data from another paper are cited but the precision should be stated here. Also, there does not seem to be any description of the method used for pH. L200: It would be useful to briefly consider the scale of the potential errors in the values of k600 applied. it was stated that mean values from another (seasonal) study were used but what was the range of values estimated in that study? These values were derived using rivers other than those studied here but are they morphologically similar?. As gas exchange in rivers is determined by river flow rates, depth, gradient and bedform, it would be worth commenting on whether these variables are similar for the study rivers and for those from which k600 was derived. L205: It was stated that the value of k600 used here was close to the mean value used in Alin et al (2011) but only their range, which is quite wide, was given. L210: Was monthly rainfall data the best resolution available and if not, why was it chosen? The rainfall data on the cited website seem to be available for hourly intervals so it would at least be useful to briefly consider the overall ranges for the months in question based on these higher resolution data. L236, Reference to Figure 2a. There is a spread of N_2O (also CH_4) for some rivers at zero salinity, but given the resolution of these plots are these values all truly riverine or does the plot mask large changes taking place at very low salinities? It is important to unequivocally make this point. To show this more clearly it might be worth considering using composite plots in which the x-axis left of zero salinity is plotted as "distance upstream". That would clearly show the variability along the length of the catchment sampled and may help reveal any tributaries with different CH_4/N_2O signatures from the main river in each case. It was also stated that the decreasing trend of N2O with salinity was only linear in the Rajang in March, but given the errors inherent in the analyses couldn't the Simutan and Sematan (incidentally, these are both labelled "(d)" in the figure caption) also be linear? L256: The lack of overall trends for N2O (also CH4) with oxygen and nutrients are stated to be in-line with the results of Borges et al (2015) and Müller et al (2016a) but this is perhaps a bit dismissive of contrasting observations made in other studies. Richey et al (1998), Bouillon et al (2009), Borges et al (2015), Teodoru et al (2015) and Upstill-Goddard et al (2017), among others, did find clear correlations of N2O with oxygen and nutrients, and Upstill-Goddard et al (2017) noted that N2O vs oxygen could be positive or negative depending on river "type". Consequently, some wider discussion of the current findings within this context seems warranted. Line 280: Presumably the very high CH4 sample that was excluded from the discussion was real, and not an artefact. It would be worth stating this, unless there is some reason to suspect otherwise. Line 296-299: Could the explanation of decreasing CH4 with salinity be a little simplistic? At least one plot (figure 3f) would look almost conservative if the high value at around salinity 10 was excluded. Is the plot therefore indicating "removal" of CH4 between an intermediate estuarine "endmember" at salinity 10 and the seawater endmember? If so it would be instructive to estimate the degree of removal of the CH4 signal (by extrapolating the linear portion of the plot at high salinity back to zero and taking the ratio of that number to the salinity 10 value) that could then be ascribed to oxidation and/or gas exchange (notwithstanding that there are a very small number of data points in the plot). L304 (Section 3.4): I wonder how meaningful it is to plot mean N2O vs mean monthly rainfall. At the very least, some discussion of the likely errors in this approach might be necessary to establish its validity. Some questions are: is the relationship between rainfall and N2O constant over different timescales? is it always linear? Could there be a variable lag time following initial rainfall (the length of which might relate to rain intensity and duration and the duration of any dry periods between successive rain events) before the N2O signal appears in the rivers? What is the likely effect of rainfall on gas exchange (could suppress or enhance it) and simple dilution (which relates to rainfall intensity). The relationship between rainfall, local hydrogeology and river flow may be complex and affect N2O processing in groundwater flow etc., so some more detailed discussion of the relationships between N2O and rainfall seems warranted. L315 onward: Upstill-Goddard et al (2017) found both positive and negative relationships between CH4 and oxygen in tropical rivers (Congo Basin) dependent upon river "type" (as for N2O), which was ascribed to the possible presence or absence of macrophytes (as also discussed earlier by Borges et al). The current results should be contrasted with these and other earlier findings. L345: It would be instructive to acknowledge the high degree of uncertainty in the flux estimates and to have some brief discussion of the likely major sources of these. Figure 2 and 3 captions. "cycles" should perhaps be "circles"

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